

REMARKS

In response to the above-identified Office Action ("Action"), Applicants traverse the Examiner's rejection to the claims and seek reconsideration thereof. Claims 1-14 are rejected. Claims 1-14 are pending in the present application. In this response, claims 1, 11 and 13 are amended, claims 2-6 are cancelled and no claims are added.

The instant application is directed to a heterostructure bipolar transistor comprising a substrate made of InP; a collector layer formed on said substrate and made of a compound semiconductor containing indium and phosphorus; a base layer formed on said collector layer and made of a p-type compound semiconductor containing gallium, arsenic, and antimony, said base layer containing carbon added as a dopant; an emitter layer formed on said base layer and made of a n-type compound semiconductor containing indium, aluminum and phosphorus; wherein at least one $\text{GaAs}_{(x)}\text{Sb}_{(1-x)}$ layer is used in said base layer and at least one $\text{In}_{(1-y)}\text{Al}_{(y)}\text{P}$ layer is used in said emitter layer, where x and y represent an As content and an Al content, respectively, in a mixed crystal composition; wherein said As content x is in the range of $0.45 \leq x \leq 0.55$ and said Al content y is in the range of $0 < y \leq 0.25$, with x and y satisfying the formula $0.49x + 1.554y > 0.36$; wherein a composition ratio of indium to aluminum in said emitter layer is in a range within which a potential energy in a conduction band edge of said emitter layer close to said base layer side is higher than that in a conduction band edge of said base layer.

I. Amendments

Applicants respectfully submit herewith amendments to claims 1, 11 and 13. Claim 1 is amended to incorporate the limitations of now cancelled claims 2-6 as well as the element of "carbon added as a dopant" which was recited in original claim 13. Claim 1 is further amended to recite "the formula $0.49x + 1.554y > 0.36$ " and "wherein a composition ratio of indium to aluminum in said emitter layer is in a range within which a potential energy in a conduction band edge of the emitter close to the base layer side is higher than that in a conduction band edge of the base layer." Support for the amendments may be found, for example, on page 17, lines 17-22 of the application.

Claim 11 is amended to replace the recitation of “y” with “z” to correct a typographical error noted by the Examiner on page 2 of the Action.

Finally, claim 13 is amended to delete the element of “carbon is doped as a dopant to said base layer” which is now recited in amended claim 1.

In view of the foregoing, the amendments to the claims are supported by the specification and do not add new matter. Accordingly, Applicants respectfully request consideration and entry of the amendments to claims 1, 11 and 13.

II. Claim Rejections – 35 U.S.C. §112, second paragraph

In the outstanding Action, the Examiner rejects claim 11 under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention.

As previously discussed, Applicants have amended claim 11 to recite “z” instead of “y.” In view of the foregoing, Applicants believe claim 11 is in compliance with 35 U.S.C. §112, second paragraph. Applicants respectfully request reconsideration and withdrawal of the rejection of claim 11 under 35 U.S.C. §112.

III. Claim Rejections – 35 U.S.C. §103

A. In the outstanding Action, the Examiner rejects claims 1-6, 9-11 and 13-14 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 4,821,082 issued to Frank et al. (“Frank”) in view of *300 GHz InP/GaAsSb/InP Double HBTs with High Current Capability and $BV_{CEO} \geq 6$ V* by Dvorak et al. (“Dvorak”). Applicants respectfully traverse the rejection.

To establish a *prima facie* case of obviousness, the Examiner must show that the cited reference teaches or suggests each of the elements of a claim. Hindsight reconstruction may not be used to modify the reference to meet the claimed invention. MPEP § 2145. Furthermore, the fact that the claimed invention is within the capabilities of one of ordinary skill in the art, without some showing of an objective reason for modifying the reference to arrive at the claimed

invention, is not sufficient to establish a *prima facie* case of obviousness. *In re Kotzab*, 217 F.3d 1365, 1371, 55 USPQ2d 1313, 1318 (Fed. Cir. 2000).

Claims 2 -6 are cancelled in the instant response therefore the rejection with respect to these claims is moot.

In regard to claim 1, Applicants respectfully submit Frank in view of Dvorak fails to teach or suggest a heterostructure bipolar transistor including at least the elements of a “base layer formed on said collector layer and made of a p-type compound semiconductor containing gallium, arsenic, and antimony, said base layer containing carbon added as a dopant,” “wherein at least one $\text{GaAs}_x\text{Sb}_{(1-x)}$ layer is used in said base layer and at least on $\text{In}_{(1-y)}\text{Al}_y\text{P}$ layer is used in said emitter layer, where x and y represent an As content and an Al content, respectively, in a mixed crystal composition,” “wherein said As content x is in the range of $0.45 \leq x \leq 0.55$ and said Al content y is in the range of $0 < y \leq 0.25$, with x and y satisfying the formula $0.49x + 1.554y > 0.36$ ” and “wherein a composition ratio of indium to aluminum in said emitter layer is in a range within which a potential energy in a conduction band edge of said emitter layer close to said base layer side is higher than that in a conduction band edge of the base layer” as recited in amended claim 1.

In the instant Action, the Examiner alleges that Figure 4 of Frank shows a state free from discontinuity of the emitter/base conduction band edge and that in column 5, lines 10-29, Frank teaches providing a base constituted of materials selected from the group $\text{Ga}(\text{P}, \text{As}, \text{Sb})$ and an emitter constructed of materials selected from the group $(\text{Al}, \text{In})(\text{P}, \text{As}, \text{Sb})$. The Examiner further alleges that Dvorak teaches a combination of an InP emitter and a GaAsSb base and that it would be apparent from these two references that a state of base/base conduction band edge continuity is achieved by making the base using $\text{GaAs}_{0.53}\text{Sb}_{0.47}$ as recited in claim 12 of Frank. In addition, the Examiner alleges it would have been obvious to use InAlP for the emitter instead of InP in view of Figure 6 of Frank and column 5, lines 10-29 which recites “providing a base constituted of materials selected from the group $\text{Ga}(\text{P}, \text{As}, \text{Sb})$ and an emitter constituted of materials selected from the group $(\text{Al}, \text{In})(\text{P}, \text{As}, \text{Sb})$.” Lastly, the Examiner alleges that the invention of the dependent claims would have been obvious based on Dvorak and states as to claim 14 that the

claimed invention does not differ in constitution or arrangement of the base from the disclosures in each of the cited references even with the limitation in temperature.

Applicants respectfully disagree with the Examiner's findings. In particular, the following compositional features found in claim 1 act to raise the emitter above the base potential in the emitter/base conduction band edge (band) discontinuity:

(i) the As content x of the base composition $\text{GaAs}_{(x)}\text{Sb}_{(1-x)}$ is in the range of $0.45 \leq x \leq 0.55$;

(ii) the Al content y of the emitter composition $\text{In}_{(1-y)}\text{Al}_{(y)}\text{P}$ is in the range of $0 < y \leq 0.25$;
and

(iii) x and y satisfy the formula $0.49x + 1.554y > 0.36$.

In addition, the above combination of elements allows for electron discharge from the emitter to the base thereby allowing the base to have a shorter electron transit time (increased speed). The effect of discharging electrons as described results in an acceleration of electrons as they are transferred from the emitter having a higher potential to the base at a lower potential.

Moreover, the additional element (iv) of doping the base layer with carbon as further recited in claim 1 yields a p-type base. The recited ranges of As content, namely the As content x of the base composition $\text{GaAs}_{(x)}\text{Sb}_{(1-x)}$ in the range of $0.45 \leq x \leq 0.55$, permits suppression of the passivation of dopant (carbon acceptor) due to hydrogen passivation.

In contrast, Frank does not teach a compositional feature that raises the emitter potential above the base potential as required by claim 1. In addition, the Examiner has not pointed to a portion of Frank expressly describing the As content x of the composition $\text{GaAs}_{(x)}\text{Sb}_{(1-x)}$ and the Al content y of the composition $\text{In}_{(1-y)}\text{Al}_{(y)}\text{P}$ which raises the emitter potential above the base potential. Thus, the invention described in Frank neither discloses nor results in the subject matter recited in amended claim 1.

The Examiner has further not pointed to and Applicants are unable to discern a portion of Dvorak curing the deficiencies of Frank with respect to each of the elements of claim 1. Instead,

Dvorak describes “C-doped GaAsSb features high doping efficiencies and displays little or no H-passivation effects.” See Dvorak, page 361. Thus, Dvorak does not teach or suggest that the passivation of dopant (carbon acceptor) due to hydrogen passivation may be suppressed by providing the above-described range of composition, namely, the As content x of the base composition $\text{GaAs}_x\text{Sb}_{(1-x)}$ in the range of $0.45 \leq x \leq 0.55$.

Since each and every element of claim 1 is not taught or suggested by the references alone or in combination, a *prima facie* case of obviousness may not be established. In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the rejection of claim 1 under 35 U.S.C. §103 over Frank in view of Dvorak.

In regard to claims 9-11 and 13-14, these claims depend from claim 1 and incorporate the limitations thereof. Thus, for at least the reasons that claim 1 is not *prima facie* obvious over Frank in view of Dvorak, claims 9-11 and 13-14 are further not obvious over the references. Applicants respectfully request reconsideration and withdrawal of the rejection of claims 9-11 and 13-14 under 35 U.S.C. §103 over Frank in view of Dvorak.

B. In the outstanding Action, the Examiner rejects claims 7-8 and 12 under 35 U.S.C. §103(a) as being unpatentable over Frank in view of Dvorak and further in view of U.S. Patent No. 4,794,440 issued to Capasso et al. (“Capasso”). Applicants respectfully traverse the rejection.

Claims 7-8 and 12 depend from claim 1 and incorporate the limitations thereof. For at least the reasons discussed in regard to claim 1, Frank in view of Dvorak fails to teach or suggest a heterostructure bipolar transistor including at least the elements of a “base layer formed on said collector layer and made of a p-type compound semiconductor containing gallium, arsenic, and antimony, said base layer containing carbon added as a dopant,” “wherein at least one $\text{GaAs}_x\text{Sb}_{(1-x)}$ layer is used in said base layer and at least on $\text{In}_{(1-y)}\text{Al}_{(y)}\text{P}$ layer is used in said emitter layer, where x and y represent an As content and an Al content, respectively, in a mixed crystal composition,” “wherein said As content x is in the range of $0.45 \leq x \leq 0.55$ and said Al content y is in the range of $0 < y \leq 0.25$, with x and y satisfying the formula $0.49x + 1.554y > 0.36$ ” and “wherein a composition ratio of indium to aluminum in said emitter layer is in a range within

which a potential energy in a conduction band edge of said emitter layer close to said base layer side is higher than that in a conduction band edge of the base layer” as further found in claims 7-8 and 12. The Examiner has further not pointed to and Applicants are unable to discern a portion of Capasso curing the deficiencies of Frank and Dvorak with respect to at least these elements. Since each and every element of claims 7-8 and 12 are not taught or suggested by the references alone or in combination, a *prima facie* case of obviousness may not be established. In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the rejection of claims 7-8 and 12 under 35 U.S.C. §103 over Frank in view of Dvorak and further in view of Capasso.

CONCLUSION

In view of the foregoing, it is believed that all claims now pending, namely claims 1 and 7-14, are now in condition for allowance and such action is earnestly solicited at the earliest possible date. If there are any additional fees due in connection with the filing of this response, please charge those fees to our Deposit Account No. 02-2666. Questions regarding this matter should be directed to the undersigned at (310) 207-3800.

Respectfully submitted,

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By: _____


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CERTIFICATE OF TRANSMISSION

I hereby certify that this correspondence is being submitted electronically via EFS Web to the United States Patent and Trademark Office on February 22, 2007.

Si Vuong

